Evaluation of Li/CF_x Cells For Aerospace Applications

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Objectives

Characterize Li/CF_x Cells for

- Capacities at various discharge rates (C/10, C/5 and C/2) and temperatures (50, 20, 0, -10 and -30°C)
- Six-month storage at -10 and -30°C for AA, and at 20 and 50°C for C Cells, respectively

Background

- Panasonic commercialized Li/CF_x cell technology in mid. 1970
- A promising primary battery for Aerospace applications such as Exploration missions, Launch vehicles, Tools and many more
  - Wide operation temperature range
  - Low self-discharge
  - High specific energy
- CF_x cathode material has a theoretical specific energy of 2260 Wh/Kg
  - Specific energy however achieved as of now is only 10% of theoretical value unless used at a very low rate of C/1000
  - Research both at Government Labs and Industries is currently in progress to improve the performance

Cell Description

- Quallion Li/CF_x 2.5 Ah AA and 6.5 Ah C cells
- Hermetically sealed cylindrical cells
- Li metal as anode
- CF_x/acetylene black as cathode
- Lithium tetrafluoroborate in Propylene carbonate and dimethoxyethane solvent as electrolyte

Cell Description-Contd.

#9 - AA cell and #10 - C Cell

Results

AA cells

Cell ID	Temperature, °C	Discharge rate, A	Capacity, Ah to 2.0 V	Capacity, Ah to 0 V	Mid-dis Voltage, V	EOD Temp, °C	Specific Energy Wh/Kg	Energy Density Wh/L	Specific Power W/Kg
1*	-10								
2*	-30								
3	20	0.5	2.00	2.49	2.401	46	399.3	659.3	80.2
4	20	2.5	0	0.12	-	62	-	-	-
5	20	1.25	1.81	1.88	2.266	80	284.0	470.0	188.9
6	20	0.25	2.00	2.64	2.447	34	434.9	712.7	41.2
7	10	1.25	1.69	2.24	2.280	60	339.7	563.4	189.6
8	50	1.25	0.13	0.13	-	76.7	-	-	-
9	30	1.25	1.12	1.63	2.123	33.3	231.7	382.5	177.4
10	-30	0.5	1.14	1.63	2.174	15.5	236.8	390.9	72.6

*storage test for six months

EOD = End-of-discharge

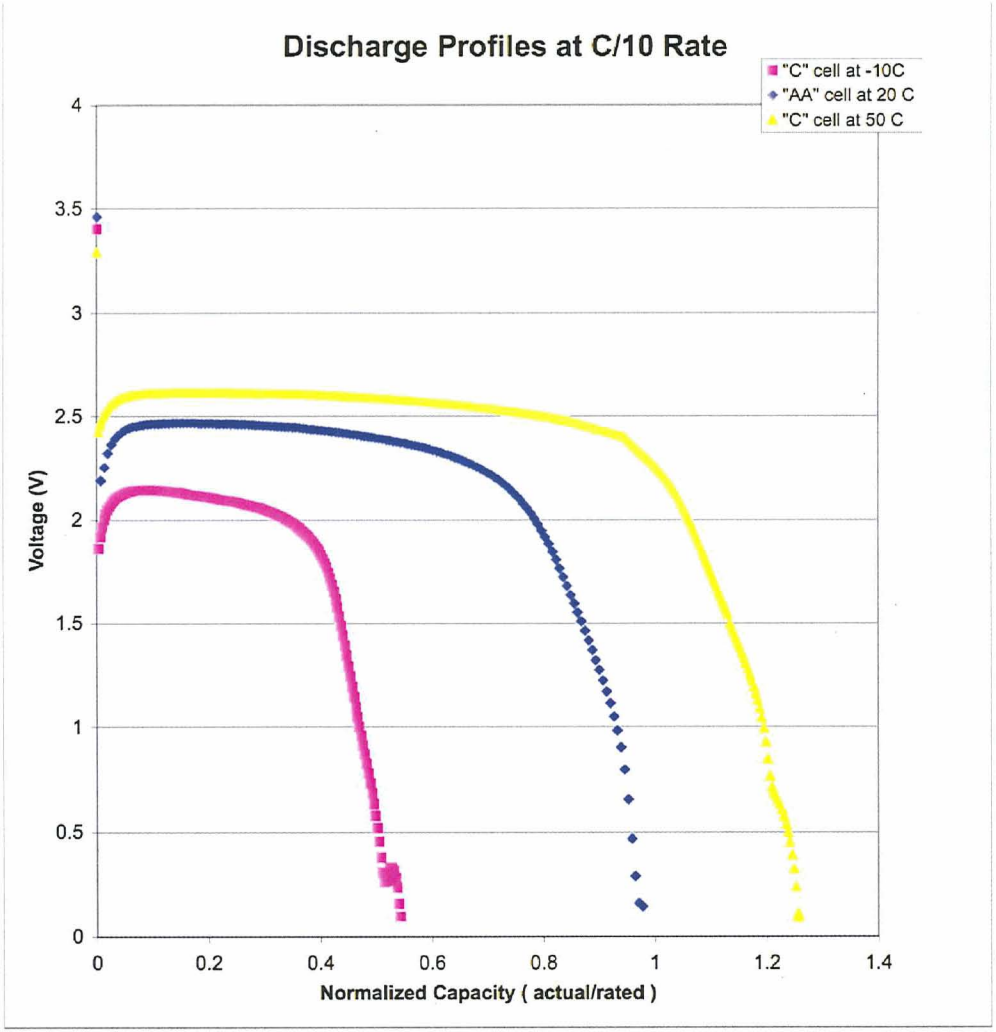
Results - Contd.

C Cells

Cell ID	Temperature, °C	Discharge rate, A	Capacity, Ah to 2.0 V	Capacity, Ah to 0 V	Mid-dis Voltage,V	EOD Temp,°C	Specific Energy Wh/Kg	Energy Density Wh/L	Specific Power W/Kg
1*	50								
2*	20								
3	20	3.25	4.78	6.84	2.143	113	355.1	502.9	168.7
4	-10	1.3	2.48	4.16	2.084	36	208.8	297.2	65.3
5	-10	3.25	2.38	4.55	2.016	63	223.6	314.7	159.7
6	-10	0.65	2.21	3.53	2.07	12	177.4	250.5	32.7
7	-10	6.5	0	0.02	-	0.2	-	-	-
	0	3.25	3.93	6.22	2.082	104	313.8	444.3	164.0
8	50	1.3	6.37	7.76	2.429	90.2	457.7	647.1	76.6
9	50	6.5	0	0.71	-	122	-	-	-
	50	3.25	0	0.60	-	130.7	-	-	-
10	50	0.65	6.91	8.17	2.581	72.2	507.7	723.5	40.4

*Storage test for six months EOD = End-of-discharge

Results - contd.



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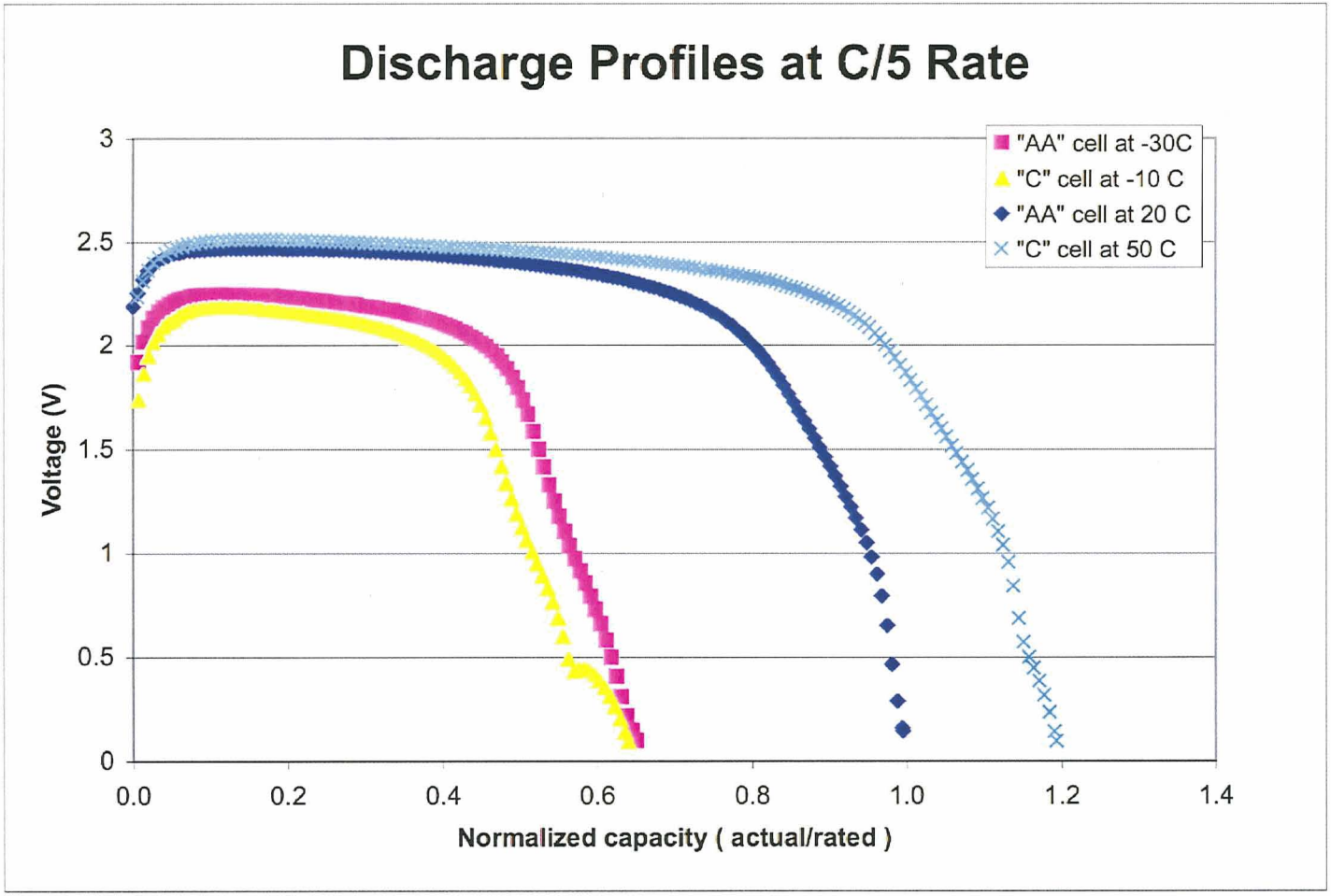

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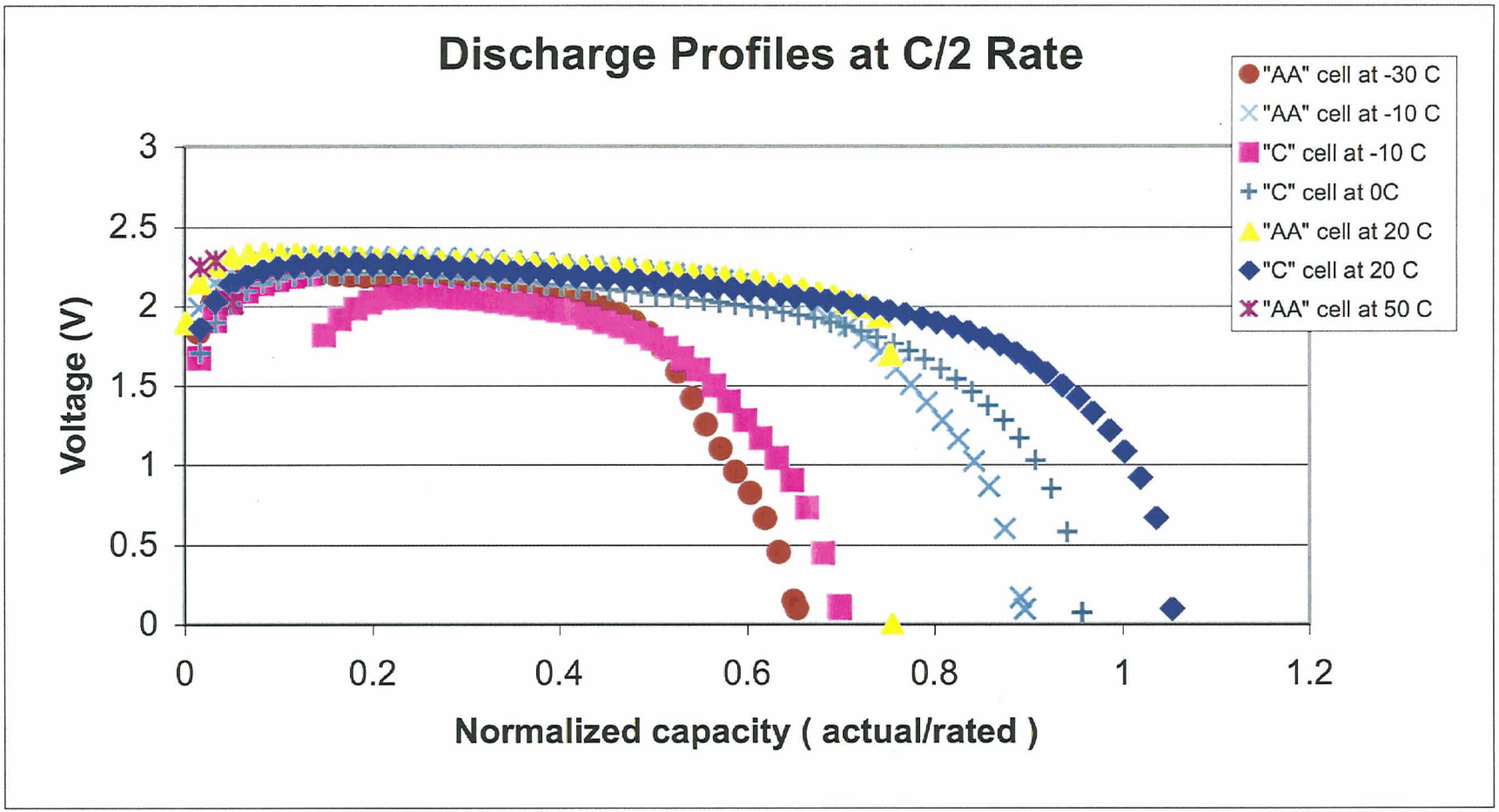

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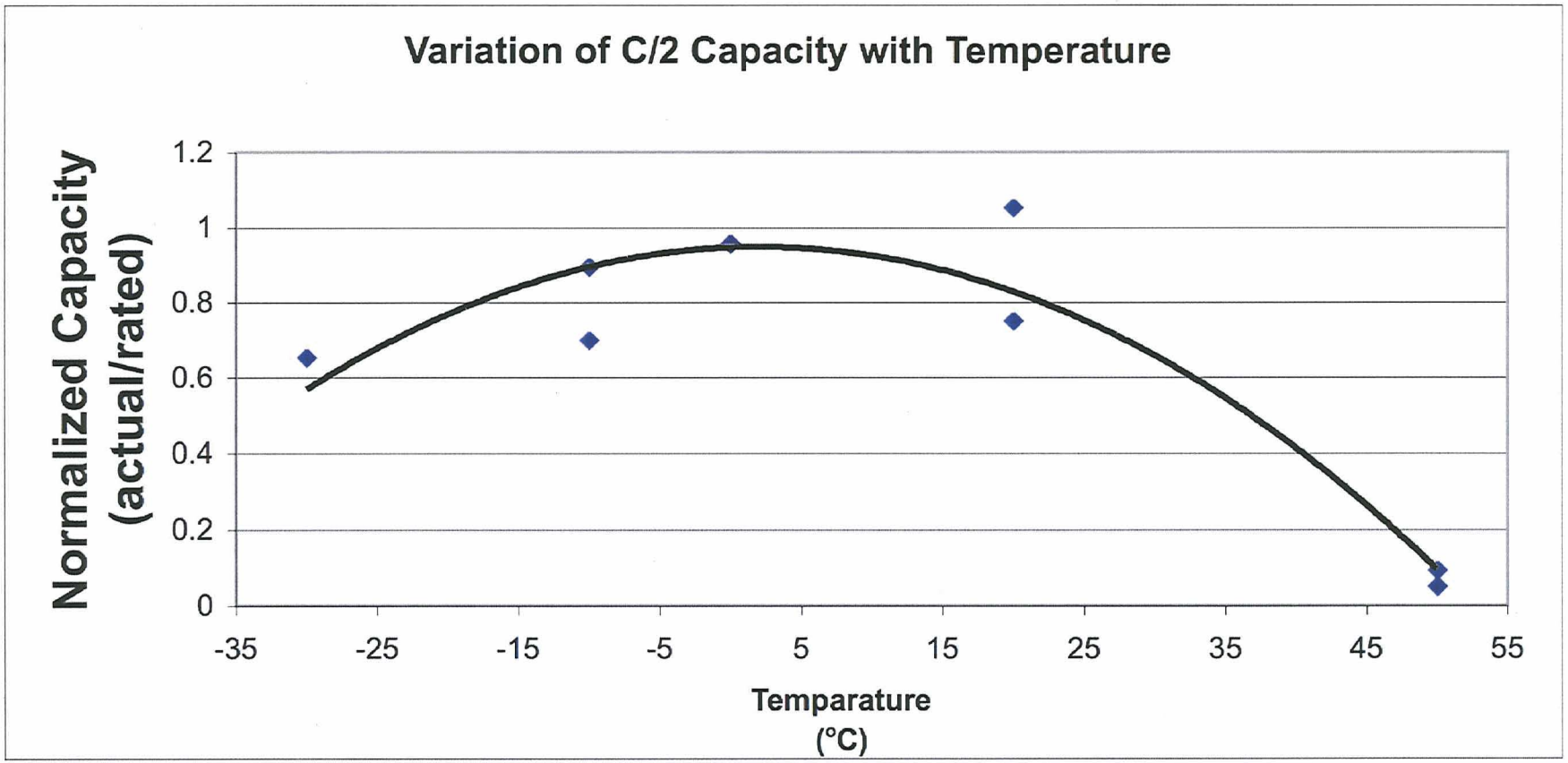

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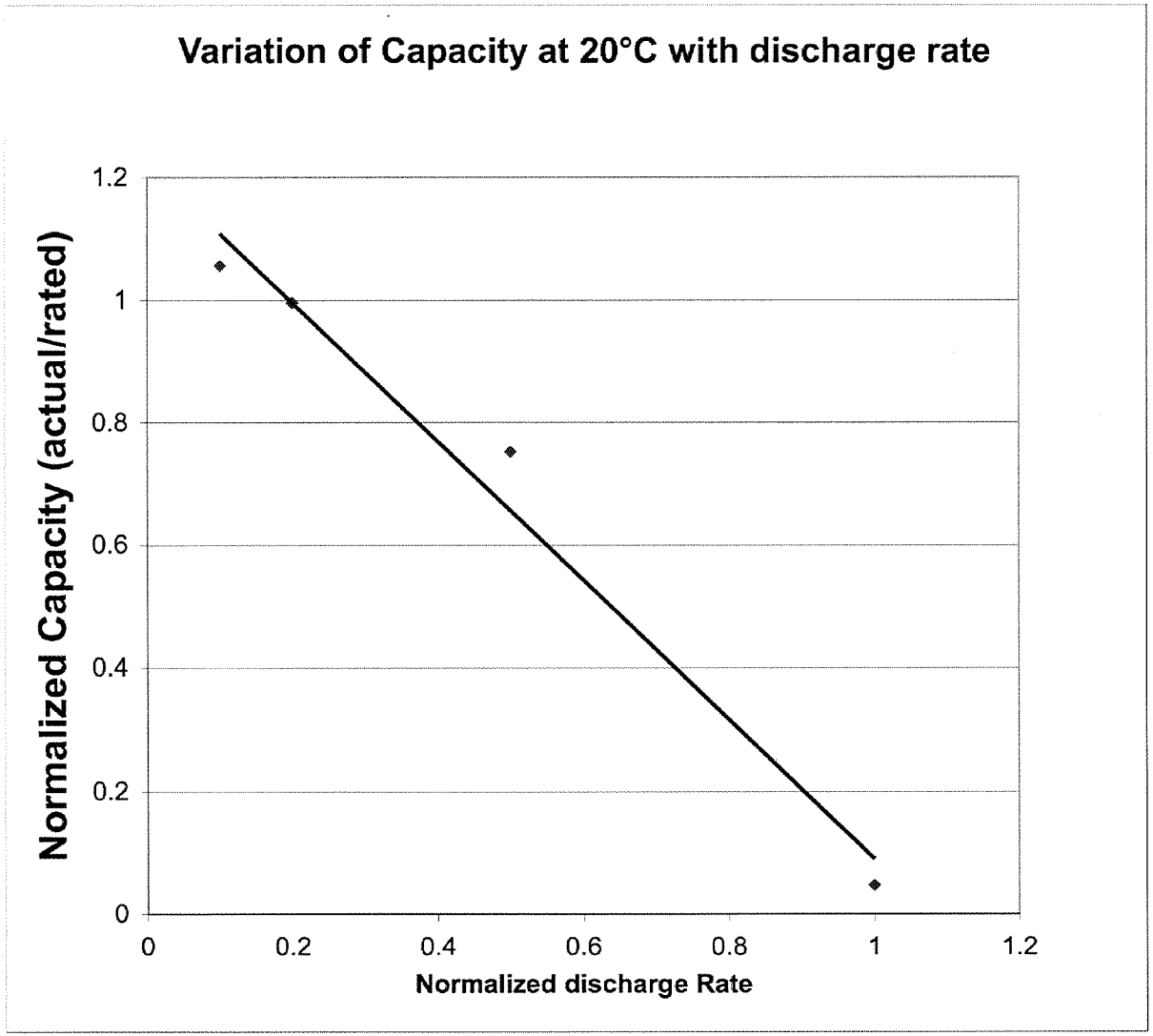

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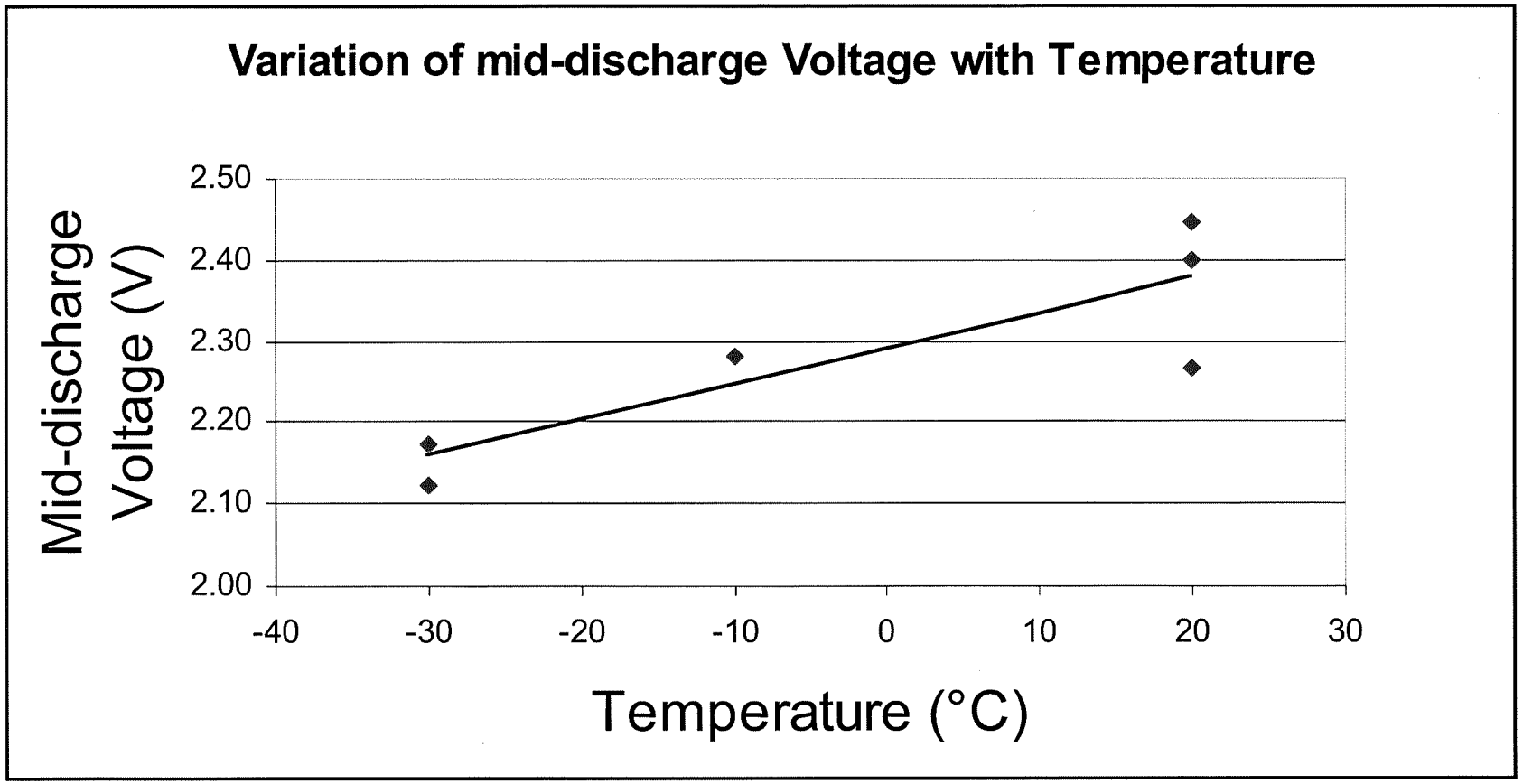

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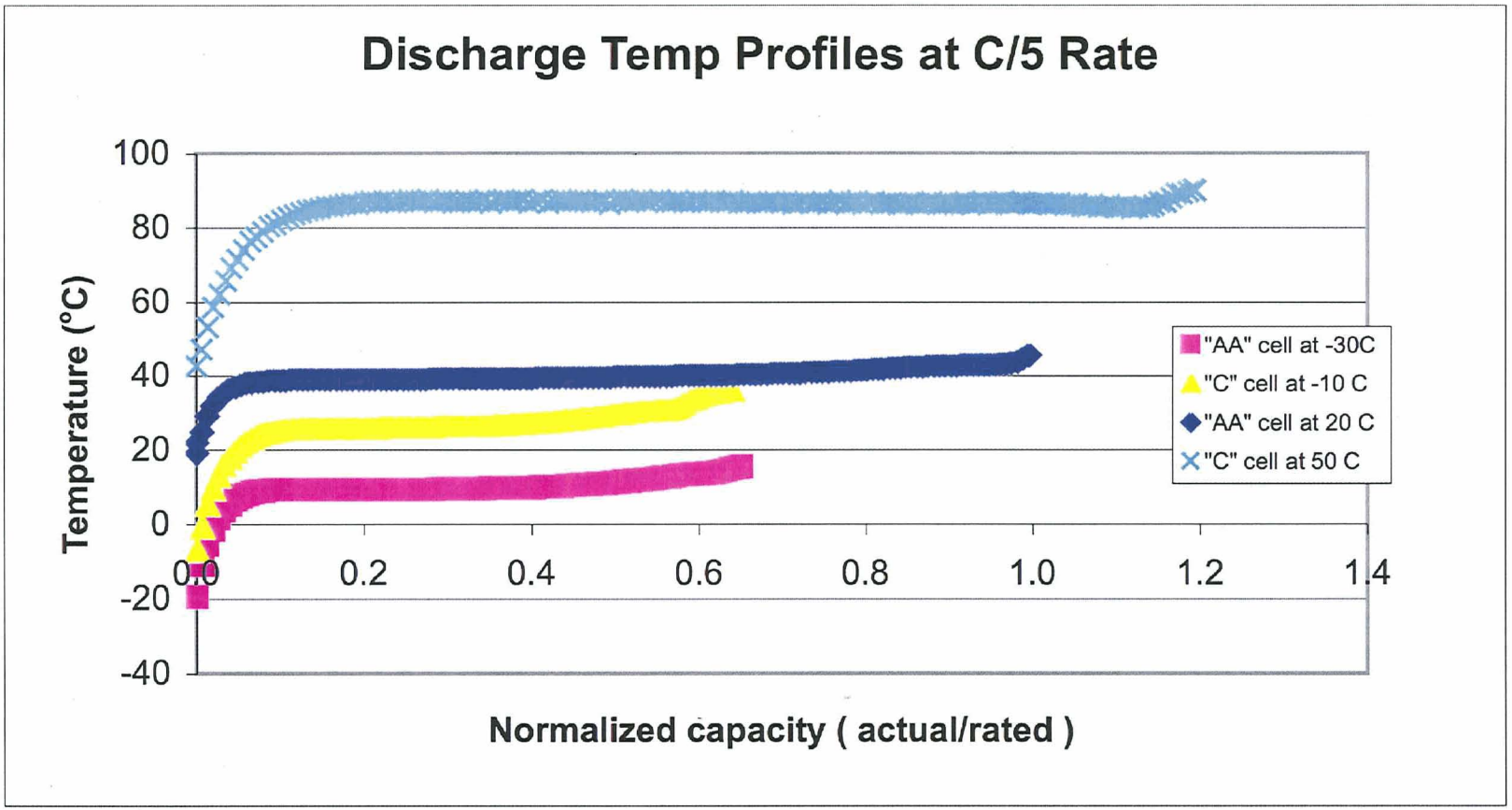

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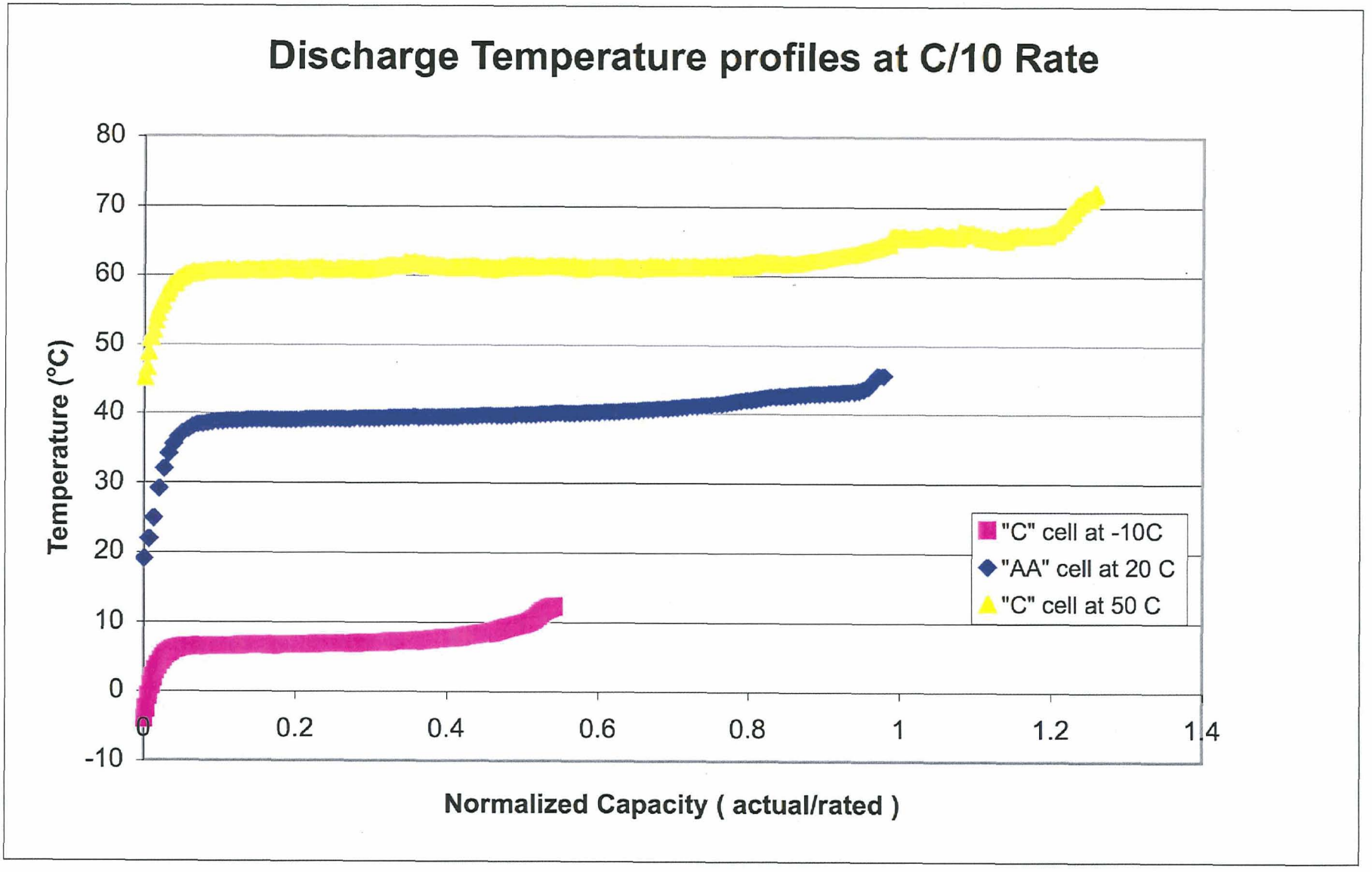

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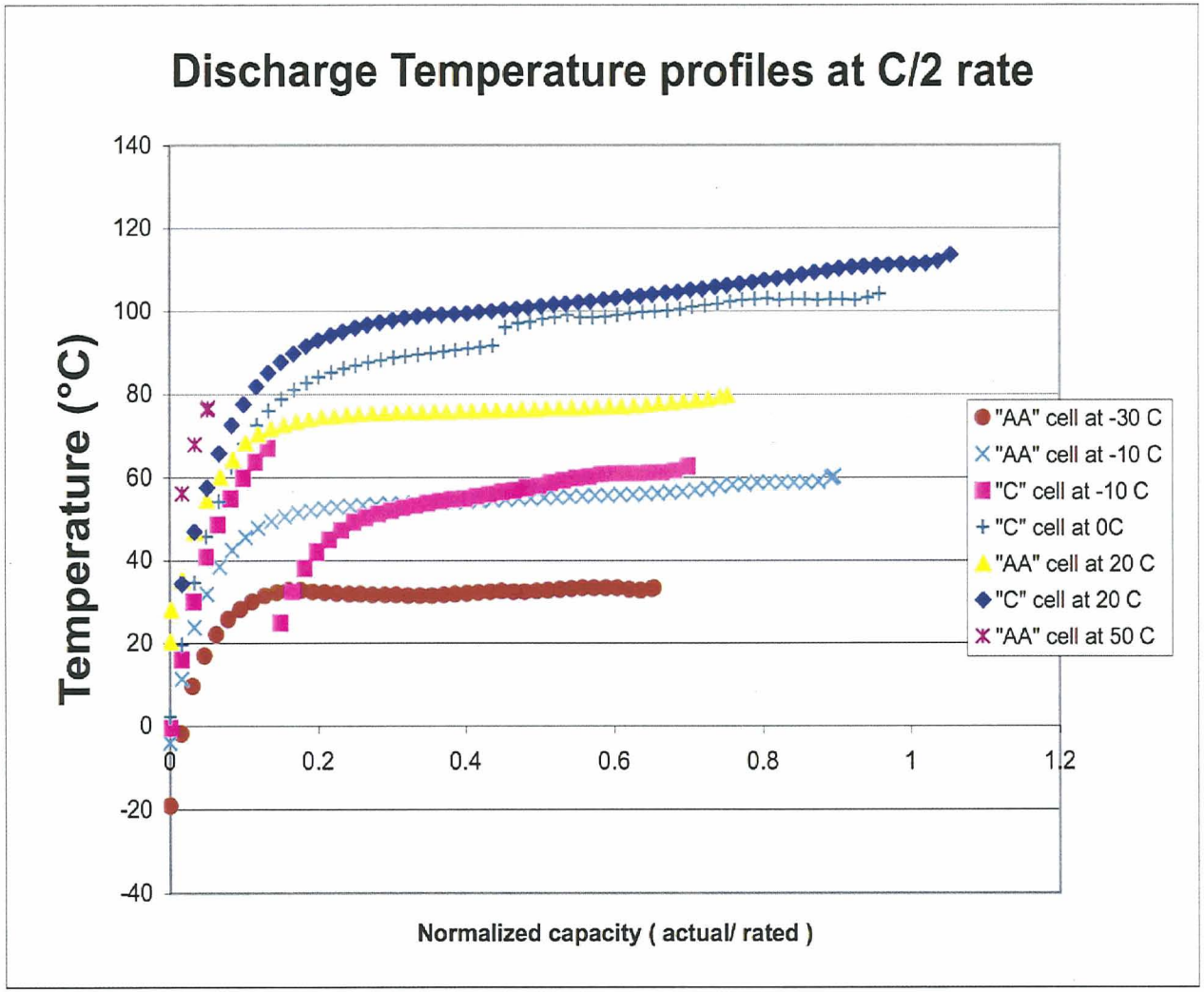

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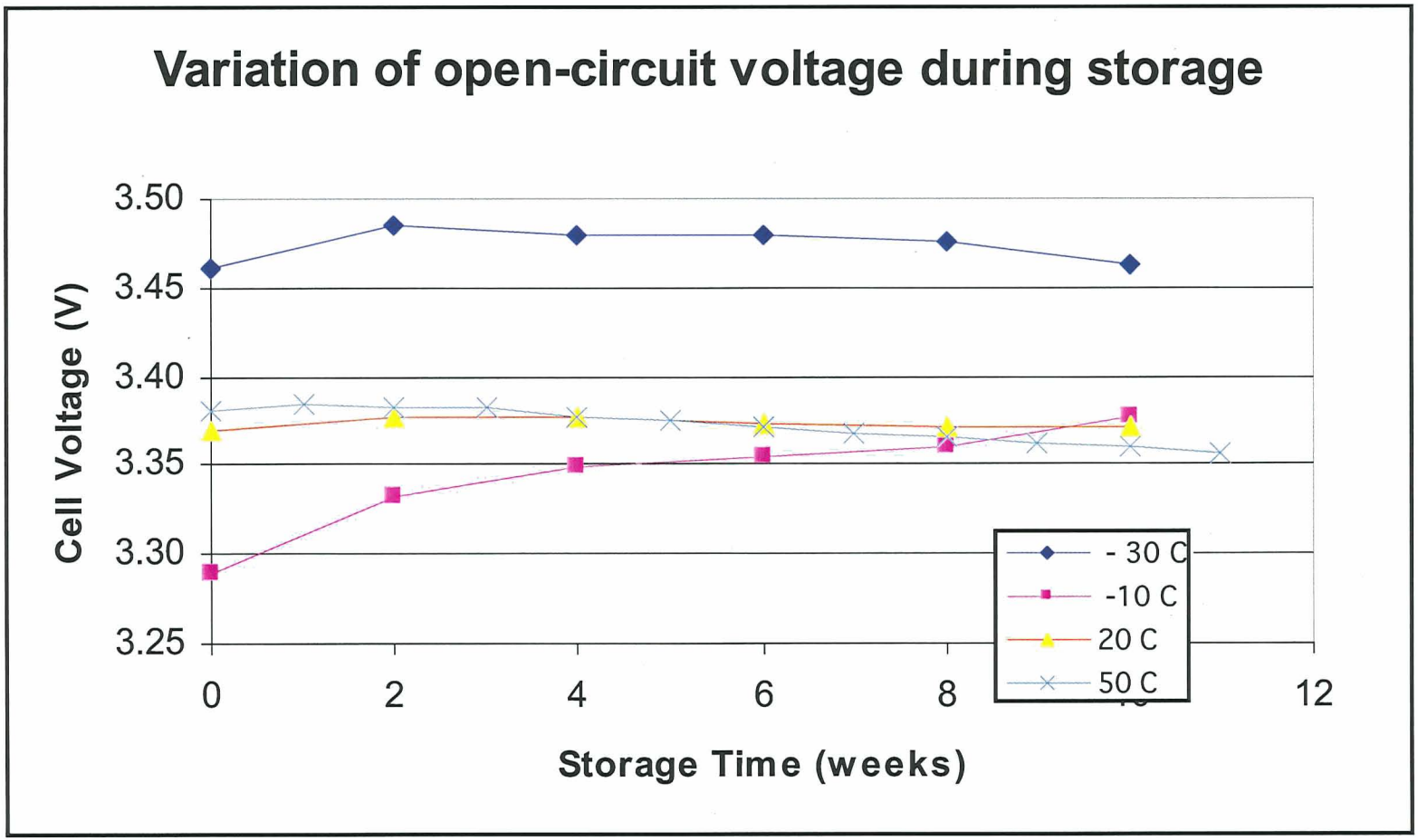

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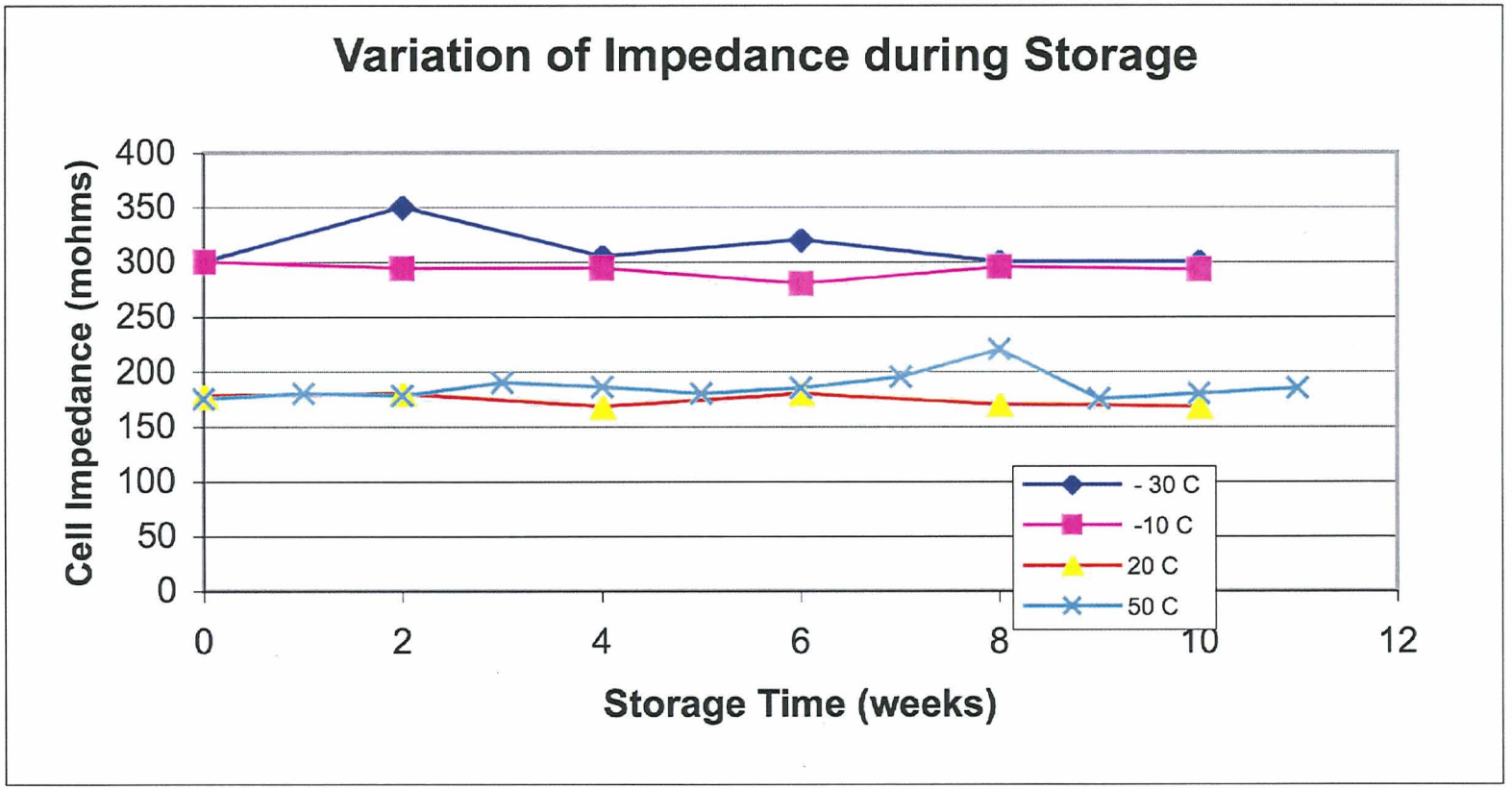

Conclusions

- Capable of performing at C/2 rate or less from -10°C to 50°C
- Temperature increased to 113°C at the end of C/2 discharge
- The C cells delivered the maximum energy of 457.7 Wh/Kg at C/5 rate at 50°C and the AA cells yielded 434 Wh/Kg at C/10 rate at 20°C
- The rate capability and low temperature performance depends on the cell size
- Further work should include environmental, self-discharge, and safety studies to qualify for the Aerospace application of the technology

Acknowledgment

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